different modeling approaches, including differential equations, cellular automata, and stochastic individual-based models (which the authors refer to as "Monte Carlo" models). Some chapters use an iterative procedure for improving models. The chapter on honeybee comb patterns addresses a single system with three entirely different modeling approaches, thus providing an opportunity to compare their relative strengths and weaknesses. The value of these case studies is further enhanced by a companion Web site where many of the computer simulations can be downloaded (in Macintosh format only).

The case studies provide concrete examples of ideas about self-organization that might otherwise seem nebulous. The formation of ant foraging trails illustrates the flexible group behaviors that can result from fixed individual rules. The distribution of honey, pollen, and brood in honeybee combs demonstrates robustness and self-repair. Several of the studies highlight concepts such as the interplay of positive and negative feedback or the capacity for self-organization to produce complex emergent patterns by specifying only a few relatively simple rules.

Although, in keeping with their emphasis on empirical questions, the authors skirt most of the theoretical debates surrounding self-organization, they tackle one central controversy in the field: can adaptation arise solely through the process of self-organization, without requiring natural selection? (Some versions of the "Gaia hypothesis," the notion that the global ecosystem functions as an adaptive organism-like entity, rest on this belief.) The authors label as a basic misconception the idea that self-organization and natural selection are alternative explanations of adaptive evolution. They present a more sophisticated scenario, one in which natural selection exploits the efficient information-coding that self-organization makes possible and molds interaction rules to create adaptive emergent patterns.

We suspect that the ideas associated with self-organization will play an increasingly prominent role in biology for some time to come, particularly as biologists strive to use new genomic data to comprehend the fundamentally self-organizing process of development. *Self-Organization in Biological Systems* presents a unique opportunity to watch a group of active researchers apply these intriguing concepts to formerly mystifying feats of social organization in animals. We know of no better guide for those who wish to understand how modeling can be used to dissect the mechanisms of self-organized biological systems.

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BOOKS: SCIENCE & RELIGION

# A Synthesis that Failed

**Thomas Dixon**

While their American counterparts were embroiled in the hostilities surrounding the 1925 Scopes evolution trial, scientific and religious leaders in Britain remained on distinctly friendlier terms. In October 1930, for example, the geneticist R. A. Fisher wrote to Bishop Ernest Barnes suggesting they might discuss the introduction of a "family allowance" scheme for Church of England clergymen as an inducement to have more children. This was, as Peter Bowler says, "a typical eugenic ploy, on the understanding that professional people were of superior genetic stock." The following year, Bishop Barnes had further discussions with Fisher and the zoologist and humanist Julian Huxley about the possibility of implementing this scheme. That one of the founders of the genetical theory of natural selection, a modernist Anglican bishop, and a leading proponent of evolutionary humanism were all to be found cooperating in this pro-eugenic enterprise is certainly striking. Their effort is just one of many surprising alliances revealed in Bowler's encyclopedic review of debates concerning science and religion in early 20th-century Britain.

*Reconciling Science and Religion* is divided into three parts. The first looks at this period from the perspective of the sciences. It is to Bowler's credit that here he works with a broad view of science, one that includes not only important developments in physics and biology but also the impact of Freudian and behaviorist psychologies on religious debates. Bowler also documents the large number of scientists who saw spiritualism as a scientific as well as a religious pursuit. In the second part, the focus shifts to the role of the churches in Britain. While remaining true to his avowed intention of painting on this large canvas with a broad brush, Bowler is still good at explaining the important differences in the prevalent theological and philosophical attitudes to science in Anglican, nonconformist, and Roman Catholic communities in Britain in this period. The final part places these debates in their broader cultural, literary, and philosophical contexts. Among the many interesting topics the author discusses here are the alternative religion of "creative evolution" proposed by George Bernard Shaw, Arthur Conan Doyle's deep interest in spiritualism, and the defenses of Christianity undertaken by popular writers such as G. K. Chesterton, Hilaire Belloc, and C. S. Lewis.

**Reconciling Science and Religion**
**The Debate in Early-Twentieth-Century Britain**
*by Peter J. Bowler*
University of Chicago Press, Chicago, 2001. 493 pp. $40, £24. ISBN 0-226-06858-7.

The overarching story Bowler tells is of a many-sided but ultimately unsuccessful project to reconcile religious and scientific beliefs and practices. At the heart of the efforts was the combination of an anti-materialistic interpretation of scientific doctrines with a liberal interpretation of Christian ones. During the early decades of the 20th century, this movement flourished in the hands of scientists who rejected the alleged materialism and anti-clericalism of their Victorian predecessors while firmly holding on to the 19th-century belief in progress. The movement's two most important scientific resources were the "new physics" and non-Darwinian theories of evolution. The apparently indeterministic and even nonmaterial subatomic world revealed by quantum physics was used to undermine views cherished by some opponents of religion. These opponents had argued that all the phenomena of life and mind were mere epiphenomena of an ultimately deterministic and mechanical material world. The "reconcilers" also enlisted Lamarckian theories to oppose the view that evolution was blind and undirected. If acquired mental and physical characteristics

**Grand synthesizer.** The zoologist, humanist, and popular writer Julian Huxley hoped to create a non-Christian religion that shared some beliefs of the Anglican "Modernists," such as a purposeful universe.

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could be inherited (and if God could act on the human mind and body), then it was possible to believe that the course of human evolution could be guided by God or humanity toward just and noble ends.

According to Bowler's interpretation, it was the undermining of this optimistic, progressionist outlook by such events as the Great War, the depression, and the rise of European fascism that contributed most to the ultimate failure of the attempted reconciliation. Thus, from the 1930s onward, it was the neo-Darwinian synthesis, anti-religious rationalism, Marxism, and Christianity (in neo-orthodox and evangelical forms) that attracted followers at the expense of the optimistic world view of modernists and humanists. These other world views were more in keeping with the growing sense of the sinfulness, injustice, and violence inherent in human societies.

In an epilogue, Bowler offers a glimpse into his own thoughts on the lessons that might be learned from this historical study. He warns readers that many proponents of science-religion reconciliation in the 1930s were from an older generation of scientists who were grounding their arguments in outdated if not downright misleading accounts of the latest scientific developments. (They were very slow, for example, to recognize the resurgence of Darwinism within biology.) One conclusion might thus be that we should be suspicious today of the reliability of the science being used by religiously motivated reconcilers.

However, a different moral could also be drawn from Bowler's account. The material in the book reveals that the issues really at the heart of discussions about "science and religion" are enduring philosophical and theological questions about nature, humanity, knowledge, and God: questions such as whether human beings are innately vicious or virtuous, what humans can know of God and nature, whether they have free will, whether they are in need of salvation, and whether they can save themselves or need to appeal to powers beyond themselves. The mistake of the reconcilers may not have been trying to answer these questions using outdated science. After all, even if they had used up-to-the-minute science, that would soon enough have become outdated as well. Their mistake may rather have lain in relying too heavily on scientific ideas when dealing with deeper questions. Bowler's account of the failed reconciliation might, therefore, be read as a warning that those who seek to ground their answers to enduring questions in the latest scientific developments should be prepared for the fact that the questions are likely to endure longer than their answers.

NOTA BENE: FOOD SCIENCE

# The Kitchen Chemist

**The Science of Cooking**
*by Peter Barham*
Springer, Berlin, 2001. 252 pp. $34.95, £19.95. ISBN 3-540-67466-7.

When the dough spilled out of the bread machine and threatened to take over the kitchen, it proved to be a simple matter to diagnose what had gone wrong. As I was told how the dough had been prepared, I realized that the recipe must have had a typo. It had called for two tablespoons of yeast instead of two teaspoons. Although this mistake was easy to spot, many kitchen disasters are much more difficult to understand. Helping cooks figure out what might have gone wrong and increasing the chances that recipes turn out as planned are at the heart of Peter Barham's *The Science of Cooking*.

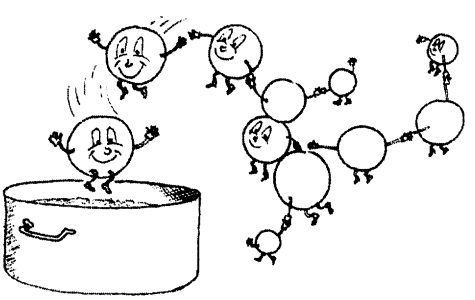
A physicist at Bristol University, Barham combines a love of science with a passion for cooking (and food) into this small and enjoyable book. Although chemistry is not a topic that everyone enjoys learning and thermodynamics tends to be even less popular, Barham does a good job explaining the key principles as they relate to food and its preparation. He discusses the changes that occur to various food molecules—fats and oils, sugars, polysaccharides, and proteins—as they are processed. Besides covering these topics, the early chapters of the book delve into aspects of what gives food its flavor and how different cooking methods and utensils affect the finished product. Although it may be tempting to skip this preliminary material, these sections are worth at least a casual read because they also introduce the terminology that reappears in later chapters.

In the rest of the book, Barham presents the science behind cooking particular types of foods such as meat, fish, pastry, and soufflés by discussing recipes that illustrate the scientific principles involved. The development of the topics reflects Barham's own discovery of cooking science and his gastronomic passions. You may be pleased to find an entire chapter devoted to "Cooking with Chocolate."

Many chapters include experiments for readers to try at home. A few of these exercises, such as frying an egg on a piece of paper, are a little elaborate. But most are simple enough to be performed without adult supervision. And they are surprisingly effective at showing how small changes to the preparation of a recipe can affect the final outcome.

The author infuses the chapters with many interesting stories and personal anecdotes. We learn that hot water often does freeze faster than cooler water, what gives meat its color, how meat is aged, and how to quickly peel chestnuts. On the more humorous side, Barham relates his first experience with garlic (in which he mistook a bulb for a clove) and the minute details of his introduction to Lutefisk.

Amateur chefs may wish to keep a copy of the book in their kitchens for its collection of "what could go wrong" tables, which are scattered throughout the chapters. In these tables, Barham lists common problems, identifies their likely causes, and suggests steps to prevent future failures. Perhaps more important, he also offers tips on how to salvage what you currently have in front of you, so that you can feed your hungry guests.



Barham is a strong advocate for the public understanding of science and is known throughout Great Britain for the many lectures, radio interviews, and television presentations he has given on the science of food. Built on his experiences with these demonstrations, *The Science of Cooking* is as much a primer on certain aspects of chemistry that we are familiar with from everyday life as it is about the arts of food preparation. Even if you prefer not to turn your kitchen into a laboratory, you will find this book worthwhile. And should you have the opportunity to catch one of Barham's talks, you may enjoy an additional treat. He often ends these presentations by mixing together eggs, milk, cream, sugar, fruit, and a little liquid nitrogen, which makes a delicious quick-freeze ice cream.

—MARC LAVINE

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